UNITED STATES PATENT APPLICATION

METHODS FOR COATING SUBSTRATES

INVENTORS:

Dennis Dean Loyd
Larry Lee Lough

Schwegman, Lundberg, Woessner & Kluth, P.A.
1600 TCF Tower
121 South Eighth Street
Minneapolis, MN 55402
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Priority

The present invention is a Continuation-in Part of and claims priority to U.S. Application No. 10/328,561 entitled "Coating of Recycled Glass" and filed on December 23, 2002, the disclosure of which is incorporated by reference herein.

Field of the Invention

The present invention is related to coatings, and more specifically to methods for coating substrates with thermo chromatic compounds, phosphorescent compounds, or luminescent compounds.

Background of the Invention

Thermochromatic compounds are compounds that change color properties in response to changes in temperature. Phosphorescent or luminescent compounds are compounds that emit light, materials that exhibit phosphorescence or luminescence are said to glow in the dark or emit light in low lighting.

Thermochromatic, phosphorescent, and luminescent compounds are expensive and therefore used conservatively in products. One use of these compounds is to sprinkle or mix these compounds in road paints to create better lighting in the dark for motorists and to delineate road hazards or rights of way.

Other uses of these compounds are non-functional and create visual aesthetics. For example, toys, posters, or ornaments which glow in the dark or change colors when subjected to temperature changes. Because of the expensive nature of these compounds, there integration has not occurred in the industry with any significant penetration.

Therefore, there is a need for new techniques that coat substrates with minimal amounts of these compounds in combination with color pigments, to create more cost effective uses and new uses for these compounds within the

industry. Moreover, some of these substrates themselves actually reduce the quantity of these compounds that are needed, because the substrates enhance the color or light characteristics of the compounds, thereby requiring less of the compounds to achieve the desired effects.

Summary of the Invention

Briefly and in general terms, methods are provided for coating substrates with thermochromatic, phosphorescent, or luminescent compounds. The coating on the substrate creates new and novel uses for the substrate by itself or when used in combination with other products. The coating can also include coloring to give the substrate desired visual appearances.

More specifically, and in one embodiment, a method to coat a substrate, is provided. A substrate is acquired as particles. Each of the particles is coated with a color mixture including at least one of a thermochromatic compound, a phosphorescent compound, and a luminescent compound.

In another embodiment, another method to coat a substrate is presented. The substrate is coated with a mixture; the mixture includes a universal resin, a solvent, a flow modifier, an adhesion modifier, a curing agent, a colorant, and at least one of a thermo chromatic compound, a phosphorescent compound, and a luminescent compound. Next, the coated substrate is cured.

In yet another embodiment, still another method to coat a substrate is taught. A mixture is created the mixture includes a universal resin, a colorant, a curing agent, a flow modifier, and at least one of a thermo chromatic compound, a phosphorescent compound, and a luminescent compound. The mixture is applied to the substrate.

Still other aspects of the present invention will become apparent to those of ordinary skill in the art from the following description of various embodiments. As will be realized the invention is capable of other embodiments, all without departing from the present invention. Accordingly, the drawings and descriptions are illustrative in nature and not intended to be restrictive.

Brief Description of the Drawings

FIG. 1 is a flowchart of a method for coating a substrate, according to one embodiment of the present invention.

FIG. 2 is a flowchart of another method for coating a substrate, according to one embodiment of the present invention.

Detailed Description of the Invention

In the following description and the drawings illustrate specific embodiments of the invention sufficiently to enable those of ordinary skill in the art to practice it. Other embodiments may incorporate structural, logical, electrical, process, and other changes. Examples merely typify possible variations. Individual components and functions are optional unless explicitly required, and the sequence of operations may vary. Portions and features of some embodiments may be included in or substituted for those of others. The scope of the invention encompasses the full gambit of the claims and all available equivalents. The following description is, therefore, not to be taken in a limited sense, and the scope of the present invention is defined by the appended claims.

In various embodiments of the present invention, the term substrate is used. A substrate is rock, slag, glass, sand, quartz, minerals, metals, plastics, or fillers. Filler substrates are materials that are added to other products for purposes of augmenting the properties of those products in some manner. These substrates are coated with the mixtures presented herein and below. The coated substrates can be stand alone products that are sold and used in the industry or the coated substrates can be integrated with other products, such as paints, adhesives, sealants, and the like and applied to other products such as walls, roads, signs, containers, clothing, and the like. In still other embodiments, the coated substrates can be used as fillers or aggregates within the native composition of other products such as concretes, plastics, metals, and the like.

In various embodiments of the present invention a mixture is used for purposes of coating the substrates. The mixtures include a universal resin, a

curing agent, a flow modifier, a colorant, and at least one of a thermochromatic compound, a phosphorescent compound, or a luminescent compound (herein after referred to as compounds). The compounds can also be chemicals, solutions, or other materials that produce light emitting or color altering properties in the mixture. The compounds can include dyes, pigments, or other polymers.

By coating substrates with the mixtures of the invention, the substrate assumes some properties of the mixture. Thus, the substrate may change its color properties when subject to temperature changes if the mixture includes a thermochromatic compound. Moreover, the substrate may glow in the dark if the mixture includes a phosphorescent or luminescent compound. Additionally, if the substrate is glass, then the substrate takes on other reflective properties and properties associated with native materials included in glass, such as radiation or ultraviolet (UV) shielding and absorbing, when the glass includes lead and other heavy metals.

FIG. 1 illustrates a flowchart of one method 100 for coating a substrate. Initially, a mixture is acquired for purposes of making a coating that is applied to the substrate. The mixture is 10% to 90% universal resin, 1% to 20% curing agent, 0.1% to 5% flow modifier, 0.1% to 40% of a colorant, and 1% to 40% of a thermochromatic, phosphorescent, or luminescent compound, chemical, or material. The creation of the mixture can occur outside the scope of the processing of the method 100. However, the mixture is acquired and used in the processing for purposes of coating the substrate.

Additionally, at 110, a substrate is acquired as particles. That substrate can be glass, stone, quartz, sand, minerals, filler used within other products, or any other inorganic substrates. In one embodiment, the substrate is inputted to a grinding device for purposes of reducing the substrate to smaller particle sizes. The size of the particles is configurable. In some embodiments, the particle sizes are less than approximately one inch in diameter. In other embodiments, if the glass substrate is leaded glass waste, the particles sizes are less than or equal to 2 millimeters in diameter sizes, and these smaller particles are treated in an acid-water solution to remove heavy metals and make them safe for human exposure and use.

At 112, the substrate particles are optionally washed and dried. Washing and drying can be achieved with conventional devices used for such purposes. For example, during a wash cycle the particles can be bathed in a tank full of tap water, or rinsed as the particles are transported. As another example, the particles can be air dried on conveyor belts or subject to heating elements or heating blowers that automatically perform the drying.

In some embodiments, the substrate is initially acquired in particle sizes that are desired, such as when the substrate is sand or other fine grain substrates. Thus, there is no need to grind the substrate in all embodiments of the invention.

At 120, the substrate particles are coated with the mixture. Coating can occur in a variety of ways. For example, the mixture can be sprayed onto the substrate particles. The substrate particles can also be submerged into a tank having the mixture. Moreover, depending upon the size of the particles, the mixture can be brushed or rolled onto the substrate particles. In still other embodiments, the substrate particles are melted and mixed with the mixture. Various types of coating are depicted at 132.

Additionally, there can be multiple coating cycles at 120, depending upon the thickness of the mixture that is desired on the substrate particles. Between each coating cycle at 120, there can also be a curing cycle or drying cycle to permit one mixture coating to fully adhere to the substrate particles. Varying levels of thickness for the mixture on the substrate particles will produce varying levels of coloring, thermochromatic, phosphorescent, or luminescent effects in the final substrate particles.

Once the substrate particles are coated with the mixture to a desired level of thickness, the substrate can be used as a standalone product or can be further integrated as a filler or additive into other products. As an example, if the substrate was sand and the mixture included phosphorescent or luminescent compounds, then the sand can be distributed as a product that can be used in landscaping or along roadways, which glow in the dark. As another example, the substrate may be glass and the mixture can include either phosphorescent or luminescent compounds and the coated substrate is mixed with road paint or stains. In this example, roadways, airport runways, or road signs can be coated with the paint-glass mixture to provide glow in the dark attributes, and the glass

adds increased reflective capabilities when subject to lights of vehicles or airplanes.

In other embodiments, building material substrates used to produce a product can be mixed with the mixture to produce improved properties or novel properties. For example, the processing of the method 100 can be integrated into the fabrication process of roofing shingles where the mixture includes a thermochromatic compound. The result is a roofing shingle that changes color when subject to temperature changes. This can improve aesthetics of a building structure and provided improved insulation capabilities of the building structure. For instance, a shingle can be manufactured with the processing of the method 100, which changes from a dark color to a clear or lighter color when temperatures increase. This will increase solar absorption or reflective capabilities of the shingles, such that the roof absorbs more solar energy during colder temperatures and reflects more solar energy during warmer temperatures. Additionally, the color changes can create a new market for roofing designs because the color or design of a building structure can change with temperature modification.

The above listed examples are intended to be sample applications which can be used with substrates that are coated with the mixtures of the present invention. These sample applications are presented only for purposes of illustration. There are a variety of other applications readily known to those of ordinary skill in the art. All such applications are intended to fall within the scope of this invention.

FIG. 2 is another method 200 for coating a substrate. Initially, at 210, a mixture is created or manufactured. That mixture includes 10% to 90% universal resin, 1% to 20% curing agent, 0.1% to 40% solvent (optional), 0.1% to 5% flow modifier, 0.1% to 5% of adhesion modifier (optional), 0.1% to 40% of colorant, and 1% to 40% of thermochromatic compound, phosphorescent compound, or luminescent compound.

The substrate can be sand, glass, quartz, rock, slag, stone, filler used in other products, or any other inorganic substrate. The substrate is in a desired particle size or can optionally be manufactured or ground into a desired particle size, as was discussed above with respect to FIG. 1.

At 220, the mixture is used to coat a substrate. The techniques used to coat the substrate can vary as depicted at 222, such that the mixture can be sprayed, rolled, or brushed onto the substrate. Alternatively, the substrate can be dipped or submerged into the mixture. Furthermore, in some embodiments, the substrate is melted and mixed with the mixture, such that the mixture becomes part of the substrate.

The substrate can be coated a single time with the mixture, or the substrate can be coated with the mixture a configurable number of iterations. Multiple coatings can be used to achieve a desired level of thickness of the mixture on the surface of the substrate. After every coating, the coated substrate can undergo a curing cycle to permit the mixture to adhere and dry on the surface of the substrate before a next coating iteration is performed.

Additionally, a coating of the mixture can be made uniformly on all sides of the substrate, or the coating can be made on less than all the sides of the substrate. Thus, the coating is configurable based on the desired properties being sought from the substrate and its subsequent use.

Once a desired thickness of the mixture is achieved on the substrate, the coated substrate can be used as a standalone product in the industry or as depicted at 230, the coated substrate can be integrated with other materials or products and used as an additive or filler to those other materials or products.

Thus, the coated substrate can be integrated with paints, stains, sealants, plastics, concrete mixtures, foams, and the like. These products can be used to further coat other products or surfaces associated with roads, walls, clothing, vehicles, devices, packaging materials, building materials, containers, and the like. Each of these products because of the uniquely coated substrate will exhibit properties and attributes associated with the native substrate and with the novel mixture.

Thus, the products will exhibit thermochromatic, phosphorescent, or luminescent properties. Moreover, the products will exhibits characteristics of the substrate, such as better UV absorption, radiation shielding or light reflectivity, in cases where the substrate includes lead and other heavy metals (*e.g.*, substrates such as leaded glass). The products integrated with or coated with the coated substrate will inherit color, light, solar, radiation, and other

beneficial characteristics which are associated with the mixture and the native substrate.

In addition to functional properties that the products inherit from the mixture and the substrate, the products will inherit aesthetic benefits associated with light and color.

The coated substrates can be integrated into a variety of and potentially limitless number of surfaces and products. Thus, the coated substrates can be used on roads, pools, aquariums, building materials (*e.g.*, wood, paints, grouts, sealants, adhesives, metals, plastics, foams, *etc.*), building structures, clothing, devices, concrete drives, concrete patios, concrete walkways, and many more. These new products and surfaces will provide improved temperature sensitivity, weather resistance, color aesthetics, light reflectivity, solar reflectivity, and other improved properties associated with the mixture and the substrate.

One of ordinary skill in the art now appreciates how a novel mixture using thermochromatic compounds, phosphorescent compounds, or luminescent compounds can be created and used to coat a variety of substrates. The substrates can then be used as new and improved stand alone products, as fillers to other products, or as coatings to other products for purposes of improving the color, light, radiation, UV, and solar properties of these products.

Moreover, because a substrate is being coated and then integrated with other products (in some embodiments), the amount of needed thermochromatic, phosphorescent, or luminescent compounds can be reduced over what has been conventionally needed to achieve color changing or light emitting characteristics. Further, in some instances, the substrate coated with the mixture enhances the color changing or light emitting characteristics of the thermochromatic, phosphorescent, or luminescent compounds. Thus, with the teachings of this invention products exhibit desirable properties at a lower expense than what has been conventionally achieved and in some instances improved color changing and light emitting properties. Additionally, products inherit beneficial properties and attributes associated with the chosen substrate that is coated; this can include UV absorption, radiation shielding, solar and light reflectivity, and the like.

Although specific embodiments have been illustrated and described herein, those of ordinary skill in the art will appreciate that any arrangement calculated to achieve the same purpose can be substituted for the specific embodiments shown. This disclosure is intended to cover any and all adaptations or variations of various embodiments of the invention. It is to be understood that the above description has been made in an illustrative fashion, and not a restrictive one. Combinations of the above embodiments, and other embodiments not specifically described herein will be apparent to one of ordinary skill in the art upon reviewing the above description. The scope of various embodiments of the invention includes any other applications in which the above structures and methods are used. Therefore, the scope of various embodiments of the invention should be determined with reference to the appended claims, along with the full range of equivalents to which such claims are entitled.

It is emphasized that the Abstract is provided to comply with 37 C.F.R. §1.72(b) requiring an Abstract that will allow the reader to quickly ascertain the nature and gist of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

In the foregoing Detailed Description, various features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments of the invention require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate preferred embodiment.